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(58) Field of search
H4J

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(54) Moving coil loudspeaker

(57) A pair of co-axial voice coils 5, 19 drive respective diaphragms 1, 2 for reproduction of the lower and higher frequencies, the high frequency diaphragm 2 being mounted in a central space in the low frequency diaphragm and at approximately the same axial location as the central portion of this diaphragm which is constructed so as to avoid diffraction and tunnel effects upon the high frequency diaphragm 2, thus permitting the latter to operate as a direct radiator. The voice coil 5 is mounted on a relatively long former 3 extending from the low frequency diaphragm 1 and works in an annular magnetic gap between a central pole piece 11 and an annular plate 12 in contact with a permanent magnet 13. The voice coil 19 works in an annular magnetic gap between a plate 20 fitted to the end of a permanent magnet 22 and an outer pole piece 18 forming part of the central pole piece 11. The low frequency diaphragm 1 may be flat, conical or domed.

Fig.1.

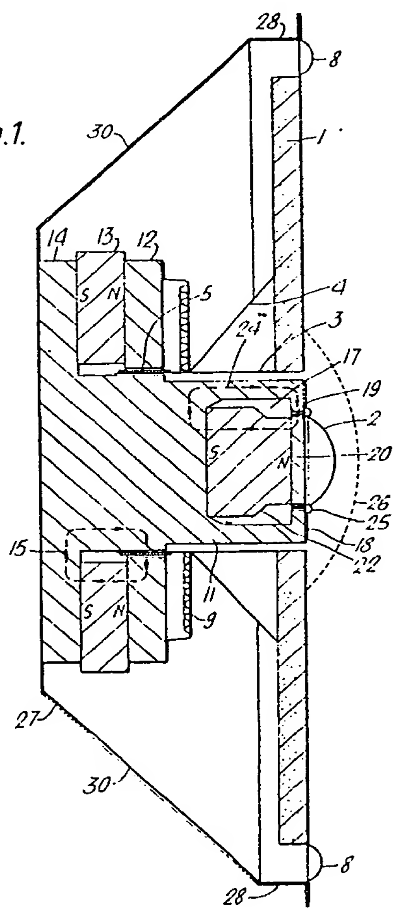

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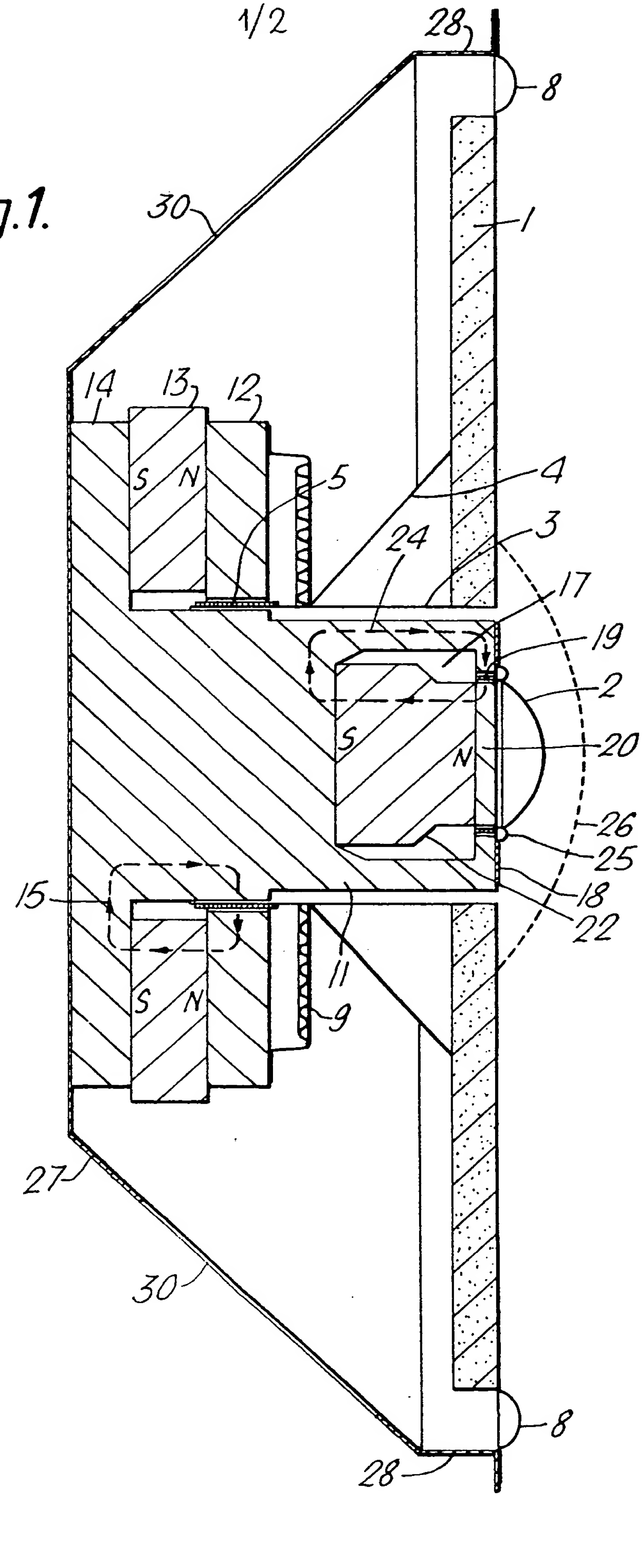
Fig.1.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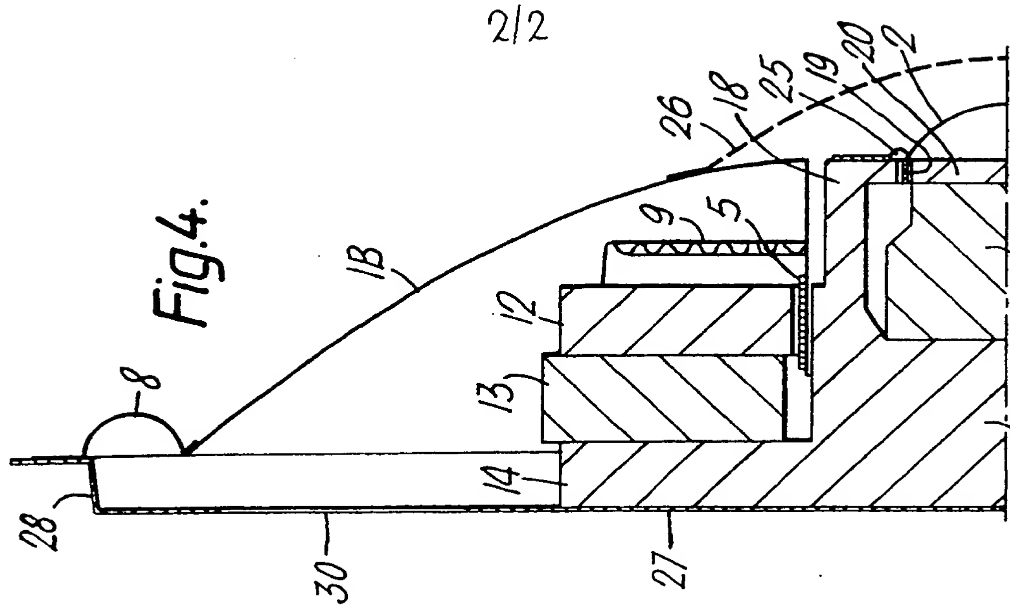

Fig.4.

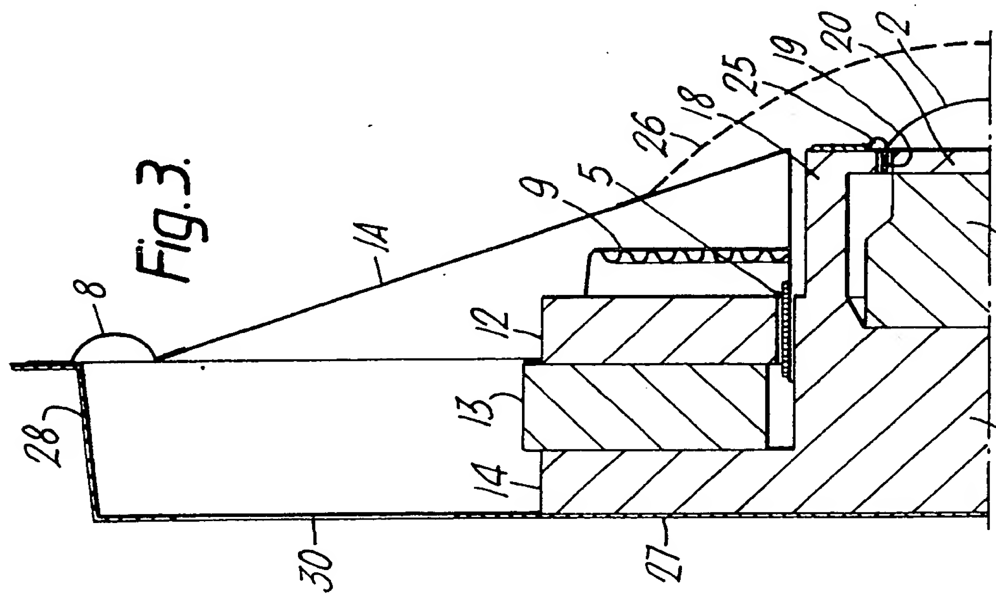

Fig.3.

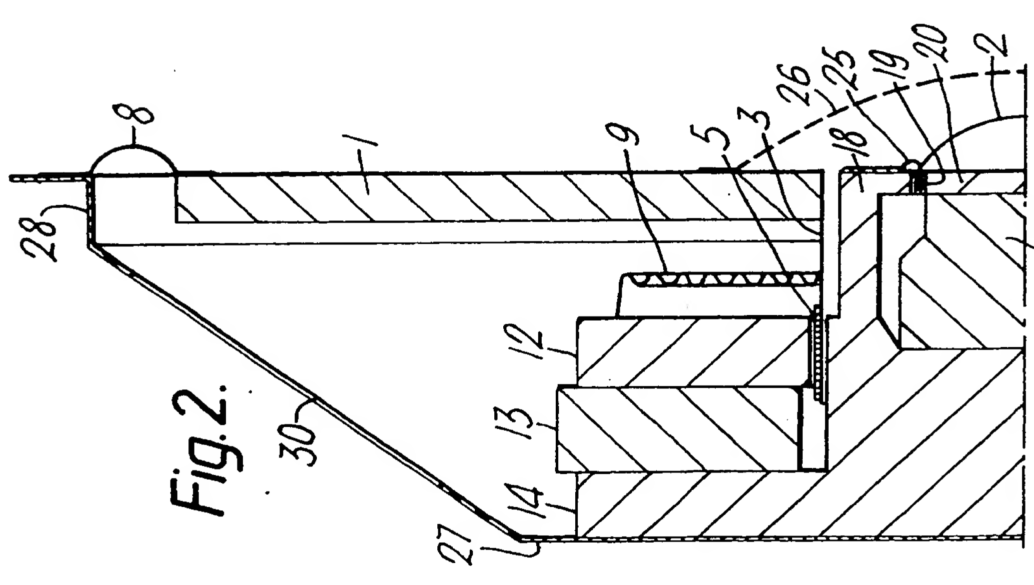

Fig.2.

SPECIFICATION

Moving coil loudspeaker

This invention relates to moving-coil loud speakers of the so-called dual concentric type, that is to say including a pair of co-axial voice coils, one of which drives a diaphragm for reproduction of the lower frequencies while the other drives a high frequency diaphragm which radiates through a central space in the low frequency diaphragm. A typical example of such a loudspeaker is shown in our prior British patent specification no: 893,838 in which the high frequency diaphragm is located at the rear of the loudspeaker. With such a construction, it is impossible for the high frequency diaphragm to operate as a direct radiator, with the attendant advantages, and instead it is horn loaded by means of a horn constituted by the interior of the central pole piece of the magnetic system together with the low frequency diaphragm.

According to the present invention, the high frequency diaphragm of a loudspeaker of this kind is mounted at approximately the same axial location as the central portion of the low frequency diaphragm and the latter is so constructed and shaped as to avoid diffraction and tunnel effects upon the high frequency diaphragm, thus permitting the latter to operate as a direct radiator. Such a result could not be obtained with a construction as described in the earlier specification referred to above, and even if the magnetic circuits were redesigned to bring the high frequency diaphragm towards the front of the loud speaker, the presence of the conical, low frequency diaphragm would inevitably lead to diffraction and tunnel effect. It is the re-design of the low frequency diaphragm to avoid these effects that makes a construction in accordance with the present invention possible.

Several different constructions of low frequency diaphragm are possible in order to achieve the required results and this diaphragm may, for example, be substantially flat. Such a diaphragm must, of course, be constructed to have adequate rigidity and may, for example, be of cellular construction. The rigidity may be increased by the inclusion of a frusto-conical secondary support which flares outwardly from a rear suspension to support the diaphragm over a circular region spaced inwardly from the front or outer suspension. As an alternative to being flat, the diaphragm may slope away rearwardly, either in the form of a straight-sided truncated cone or in the form of a dome.

The required result in accordance with the invention is preferably achieved by a construction in which a central pole piece defining the inner side of an annular air gap in a magnetic circuit for the voice coil of the low frequency diaphragm extends forwardly to form part of the magnetic circuit for the voice coil of the high frequency diaphragm. In particular, this pole piece may be shaped to define the outer boundary of an annular air gap in the magnetic circuit for the high frequency voice coil.

Examples of different types of construction in accordance with the invention will now be described in more detail, with reference to the accompanying drawings, in which:

Figure 1 is an axial section of a dual concentric loudspeaker having a flat diaphragm with a secondary support;

Figure 2 is a view similar to Figure 1 of one half of a loudspeaker having a flat diaphragm with no secondary support;

Figure 3 is a view similar to that of Figure 2 in which the low frequency diaphragm is in the form of a straight-sided truncated cone sloping back from the high frequency diaphragm; and

Figure 4 is a view similar to Figure 3 in which the low frequency diaphragm is in the form of a dome sloping back from the high frequency diaphragm.

Turning first to Figure 1, a dual-concentric loudspeaker comprises a flat, annular LF diaphragm 1 which may be of cellular construction to give increased rigidity. A domed HF diaphragm 2 is concentric with and works within the circular central space of the LF diaphragm 1. Since the diaphragm 2 is mounted at substantially the same axial location as the diaphragm 1, it can act as a direct radiator and the shaping of the diaphragm 1 avoids any diffraction and tunnel effect.

Turning to the constructional and magnetic details, the diaphragm 1 is carried by a former 3 which also serves as a mounting for a frusto-conical secondary support 4 which gives the diaphragm 1 added rigidity. This necessitates a relatively long former 3 which, at its inner end, carries a normal voice coil 5. The diaphragm 1 is mounted by an outer suspension 8 and a rear suspension 9, the latter being fixed to the voice coil former 3 adjacent the inner end of the secondary support 4. The diaphragm 1 can thus vibrate about the two suspensions under the control of the voice coil 5.

The voice coil 5 works in an annular magnetic gap defined between a central pole piece 11 and an annular plate 12. A flat annular permanent magnet 13 which, because of its shape is conveniently made of ferrite, is sandwiched between the plate 12 and an annular extension 14 of the pole piece 11. The polarity of this magnet may, for example, be as illustrated with a north pole at the right and a south pole at the left so that the magnetic circuit follows the course of dotted line 15 to traverse the air gap in the usual way and thus to react with the voice coil 5.

The central pole piece 11 extends forwardly from the voice coil 5 and is hollowed out at 17 so as to define an outer pole piece 18 for the voice coil 19 of the HF diaphragm 2. The inner side of the air gap is defined by a plate 20 fitted to the end of a central permanent magnet 22 which is located by the inner end of the internal hollow 17. Owing to its greater length, this magnet is preferably of the metal type. With the polarities illustrated the magnetic circuit is shown in dotted lines at 24 so as to traverse the air gap and thus control the voice coil 19. The use of a single pole piece to define the inside of the air gap for the LF voice coil 5 and the outside of the air gap for the HF voice coil 19 leads

to compactness and economy of components and thus permits the desired relationship between the two diaphragms.

The HF diaphragm 2 is carried by a suspension 25 and is protected by a permeable dust cover 26. The loud speaker has a frame 27 secured to the rear portion 14 of the pole piece 11, which extends forwardly at 28 to support the outer suspension 8 for the LF diaphragm 1. This frame is provided with ventilation 30 which allows access of air to all the internal moving parts.

The loudspeaker shown in Figure 2 which is, of course, symmetrical about its axis, is identical in principle to that of Figure 1 and corresponding components are shown by the same reference numerals. The only difference is a structural one in that the secondary support 4 for the diaphragm 1. is omitted and the diaphragm relies on its own inherent rigidity. The omission of the support 4 means that the length of the voice coil former 3 can be reduced accordingly with a corresponding reduction in length of the central pole piece 11, thus leading to a more compact overall construction. The magnetic circuits and other details are all the same as already described in relation to Figure 1.

The constructions of Figures 3 and 4 are again similar to that of Figure 2, except for the shaping of the LF diaphragm in each case. Again the corresponding components are shown by the same reference numerals and it will be seen that the voice coil former 3 and pole piece 11 are of the same reduced length as in Figure 2.

In the construction of Figure 3, the LF diaphragm, instead of being flat is of straight-sided frusto-conical shape, being shown as IA. The cone tapers in the direction of sound propagation, that is to say in the opposite direction to a normal conical diaphragm and it is this shaping which leads to the avoidance of diffraction and tunnel effects. Expressed in other words, the cone slopes backwardly from the HF diaphragm 2 rather than forwardly as with a normal construction of loudspeaker.

The LF diaphragm in the construction of Figure 4, shown as IB, also slopes rearwardly, but in this case, in the form of a dome rather than a cone with a central space for the HF diaphragm 2. Again diffraction and tunnel effects are avoided.

In both Figures 3 and 4 the shaping of the LF diaphragm gives it inherent rigidity so that it can be made of a normal diaphragm material.

CLAIMS

1. A moving coil loudspeaker including a pair of coaxial voice coils driving respective diaphragms for reproduction of the higher and lower frequencies and in which the high frequency diaphragm is mounted at approximately the same axial location as the central portion of the low frequency diaphragm and the latter is so constructed and shaped as to avoid diffraction and tunnel effects upon the high frequency diaphragm, thus permitting the latter to operate as a direct radiator.

2. A moving coil loudspeaker according to claim 1 in which the low frequency diaphragm is substantially flat.

3. A moving coil loudspeaker according to claim 2 in which the low frequency diaphragm is of cellular construction.

4. A moving coil loudspeaker according to claim 2 or claim 3 which the low frequency diaphragm includes a frusto-conical secondary support which flares outwardly from a rear suspension to support the diaphragm over a circular region spaced inwardly from a front or outer suspension.

5. A moving coil loudspeaker according to claim 1 in which the low frequency diaphragm slopes away rearwardly in the form of a straight-sided truncated cone.

6. A moving coil loudspeaker according to claim 1 in which the low frequency diaphragm is domed with a central space for the high frequency diaphragm.

7. A moving coil loudspeaker according to any one of the preceding claims in which a central pole piece defining the inner side of an annular air gap in a magnetic circuit for the voice coil of the low frequency diaphragm extends forwardly to form part of a magnetic circuit for the voice coil of the high frequency diaphragm.

8. A moving coil loudspeaker according to claim 7 in which the pole piece is shaped to define the outer boundary of an annular gap in the magnetic circuit for the high frequency voice coil.

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